(12) UK Patent Application (19) GB (11) 2 202 380 (13) A

(43) Application published 21 Sep 1988

(21) Application No 8706699

(22) Date of filing 20 Mar 1987

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(51) INT CL⁴
H01Q 11/08

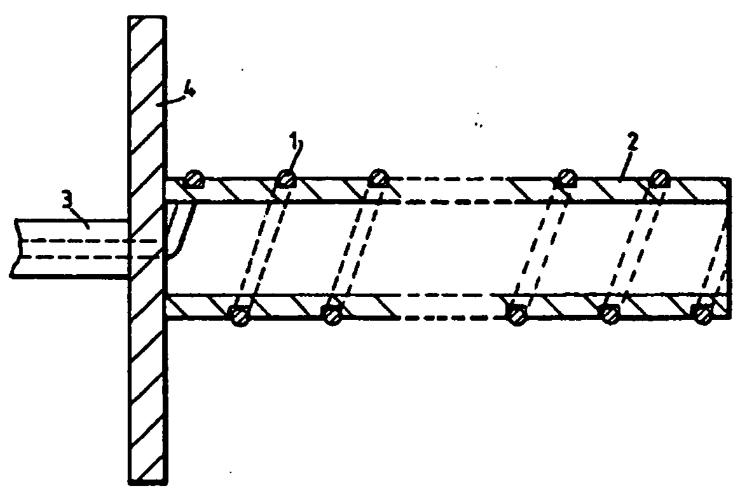
(52) Domestic classification (Edition J):
H1Q DJ

(56) Documents cited
GB A 2174249 GB 1198410 GB 0980873
GB 0778518 GB 0762415 GB 0720114

(58) Field of search
H1Q
Selected US specifications from IPC sub-class
H01Q

(54) Helical antenna

(57) To match a helical antenna comprising a conductive helix (1) to a desired impedance, typically a 50-ohm feeder (3), the helix is capacitively loaded with dielectric material of suitable dimensions and dielectric constant. Suitably the helix (1) surrounds and is at least partially embedded in a dielectric tube (2). Dielectric material may be added until the antenna impedance substantially matches the desired value, for example by coating with a solution of dielectric material in a volatile solvent.



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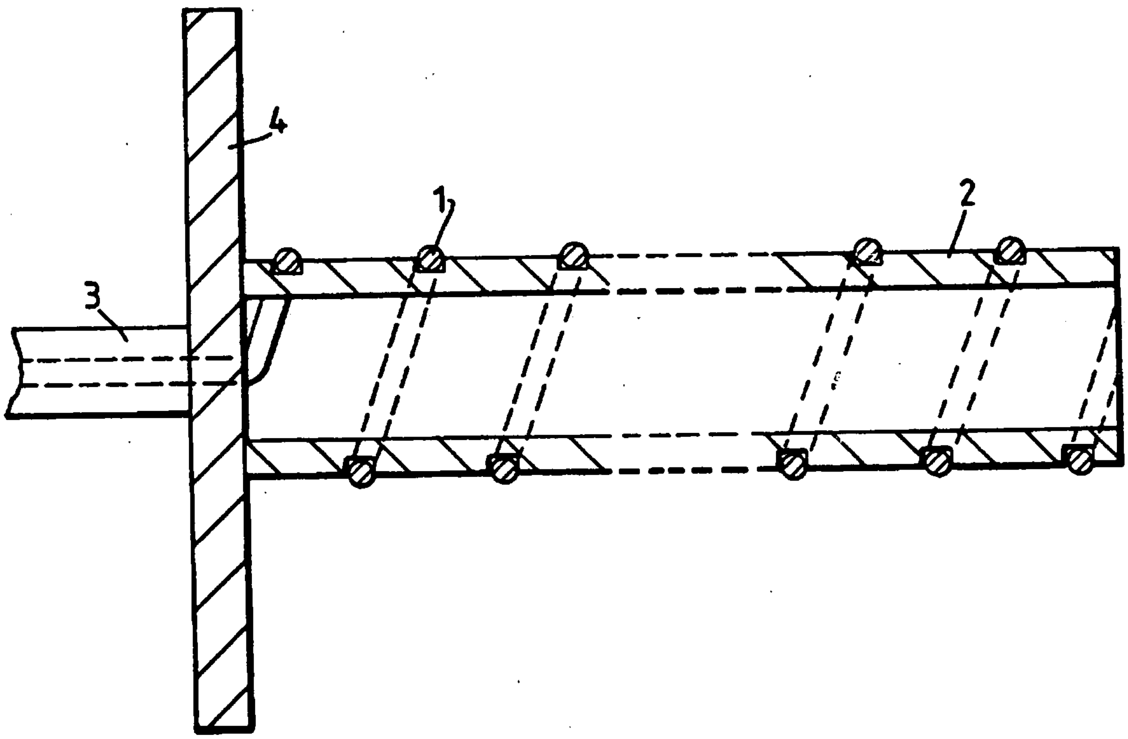
The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.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DESCRIPTION:

"ANTENNA"

The invention relates to a substantially matched helical antenna, and to a method of substantially matching a helical antenna.

Helical antennas, which have been known since 1947, have well-defined characteristics and are operable over substantial bandwidths, which makes them useful for, for example, testing other antennas. The impedance of a helical antenna is generally in the range 100-150 ohms, typically 140 ohms. To match the impedance of the antenna to a desired value, typically 50 ohms, for coupling the antenna to a signal source or to a receiver, a transformer is commonly used between the antenna and a feeder which is usually a transmission line such as a coaxial line or which may be a waveguide. This has the disadvantage of requiring the use of a separate additional component; furthermore, the transformer may be relatively large at low frequencies (below 1 GHz), and difficult to realise at very high frequencies (many tens of GHz). As an alternative, the configuration of the helix itself adjacent the end from which it is fed may be adjusted to provide an impedance transformation: see for example "Measured performance of a broadband matching section for peripherally fed helical antennas" by D.E. Baker, Transactions of the South African Institute of Electrical Engineers, Vol. 76, part 2, pages 56-61 (June 1985). The accuracy of construction of such a configuration may be critical to achieving suitable impedance matching.

According to a first aspect of the invention, a helical antenna comprises a conductive helix capacitively loaded with dielectric material so that the impedance of the antenna substantially matches a desired impedance.

According to a second aspect of the invention, a method of reducing the impedance of a helical antenna comprising a conductive helix comprises capacitively loading the helix with dielectric material so that the impedance of the antenna

substantially matches a desired impedance.

Suitably, the helix surrounds and is at least partially embedded in a tube of dielectric material.

The method may comprise adding dielectric material adjacent the helix until the antenna impedance substantially matches the desired value.

It is known from GB 720 114 and GB 762 415 that the helix of a helical antenna may surround, and may furthermore be surrounded by, dielectric material. In both those patent specifications, the dielectric material was provided to support the helix. The possibility of additionally using the dielectric material favourably to influence the impedance of the antenna was apparently not appreciated: GB 720 114 refers to the use of a matching section so as to present the correct impedance to the coaxial feed cable from the transmitter or receiver, and GB 762 415, in which the helix is fed from a waveguide via a probe, disloses a movable piston located at one end of the guide in order to facilitate impedance matching of the probe from the helix into the guide.

The invention provides the advantage that the presence of a dielectric tube may in any case be desirable to support the helix, particularly for an antenna for operation at a frequency of several GHz or more. However, rather than using a material of low dielectric constant (such as Styrofoam or PVC each referred to in the above-mentioned paper by D.E. Baker), a tube may be used of sufficiently high dielectric constant and sufficient thickness so as also to reduce the antenna impedance to a desired value.

The capacitive loading provided by the dielectric material is greatest if the material is immediately adjacent the helix; adding further material at a greater distance provides progressively less additional loading. It is therefore desirable that the material should be of sufficient thickness to provide adequate capacitive loading, but not such as might result in undesired modes being excited; for example, a helix surrounding a

rod of dielectric material might also tend to act as a dielectric rod antenna. A material of suitable dielectric constant may be selected bearing this in mind. A dielectric constant in the range of 2-4 may for example be suitable for an antenna operating at around 10 GHz. Using a material of given dielectric constant, the quantity of material required, as measured in terms of wavelength, remains constant with frequency, and hence in absolute terms, its dimensions decrease with increasing frequency.

An embodiment of the invention will now be described, by way of example, with reference to the diagrammatic drawing, the sole Figure of which is a side view, mainly in cross-section, of a helical antenna embodying the invention. The cross-section is taken in a plane including the axis of the antenna. The antenna, intended for operation at frequencies around, for example, 10 GHz, comprises a conductive wire most of which is wound in the form of a helix around a circular cylindrical tube 2 of dielectric material. The helix is axially fed at one end by a coaxial line feeder 3 (depicted schematically), the wire 1 for this purpose passing through an aperture (not shown) in the wall of the tube 2 and being connected to the centre conductor of the feeder line 3. (The helix may alternatively be fed peripherally.) The centre conductor of the coaxial line passes through a conductive circular disc 4 to which the outer conductor of the line is connected so that the disc forms a ground plane for the helix.

The proximity to the helix of the dielectric material of the tube 2 provides capacitance loading of the helix that reduces the impedance presented by the helix. To increase the loading, the wire 1 may be at least partially embedded in the tube 2; in this particular embodiment, the wire was laid in a helical groove of rectangular cross-section having a depth which was 50 % of the diameter of the wire. Suitable loading to provide optimum matching may be determined empirically by initially providing a degree of loading (dependent <u>inter alia</u> on the depth of the

groove) that does not quite reduce the antenna impedance to the desired value, and then increasing the loading by coating the helix and tube with one or a succession of layers of a dielectric solution from which the solvent evaporates to deposit dielectric material adjacent the helix until the antenna impedance is substantially optimised. (For simplicity, this additional dielectric material is not shown in the drawing).

In a constructed embodiment for operation in the frequency range 6.9-10.9 GHz, the tube 2 had an outer diameter of 9.5 mm and an inner diameter of 6.1 mm; the tube was of polystyrene having a dielectric constant of about 2.5. The diameter of the conductive wire 1 was 1 mm; the wire additionally had a thin plastics coating, being suitable for coil winding. To increase the capacitive loading, the antenna was provided with several successive dielectric coatings each made by immersing the helix and dielectric tube in a viscous solution prepared by dissolving polystyrene in a volatile organic solvent; the assembly was removed from the solution and the solvent allowed to evaporate from the layer of solution adhering to it. It was found that the first coating produced the largest change, presumably owing to the gaps between the helix and the groove in the dielectric tube being filled. Further coatings produced small but nevertheless progressive increases in capacitive loading. Using a feeder with a characteristic impedance of 50 ohms, the VSWR of the antenna did not exceed 1.6 over its operating frequency range and was better than 1.5 over most of the range. It is believed that these figures could be improved upon by providing a dissipative load at the free end of the antenna, for example a resistive termination of the helix or lossy dielectric material in that region.

CLAIMS:

1. A helical antenna comprising a conductive helix capacitively loaded with dielectric material so that the impedance of the antenna substantially matches a desired impedance.

2. An antenna as claimed in Claim 1 wherein the helix surrounds and is at least partially embedded in a tube of dielectric material.

3. An antenna as claimed in Claim 1 or 2 in combination with a feeder transmission line or waveguide, wherein the impedance of the antenna substantially matches the characteristic impedance of the feeder.

4. A method of reducing the impedance of a helical antenna which comprises a conductive helix, the method comprising capacitively loading the helix with dielectric material so that the impedance of the antenna substantially matches a desired impedance.

5. A method as claimed in Claim 4 which comprises adding dielectric material adjacent the helix until the impedance of the antenna substantially matches the desired impedance.

6. A matched helical antenna substantially as herein described with reference to the drawing.

7. A method of matching a helical antenna substantially as herein described with reference to the drawing.

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